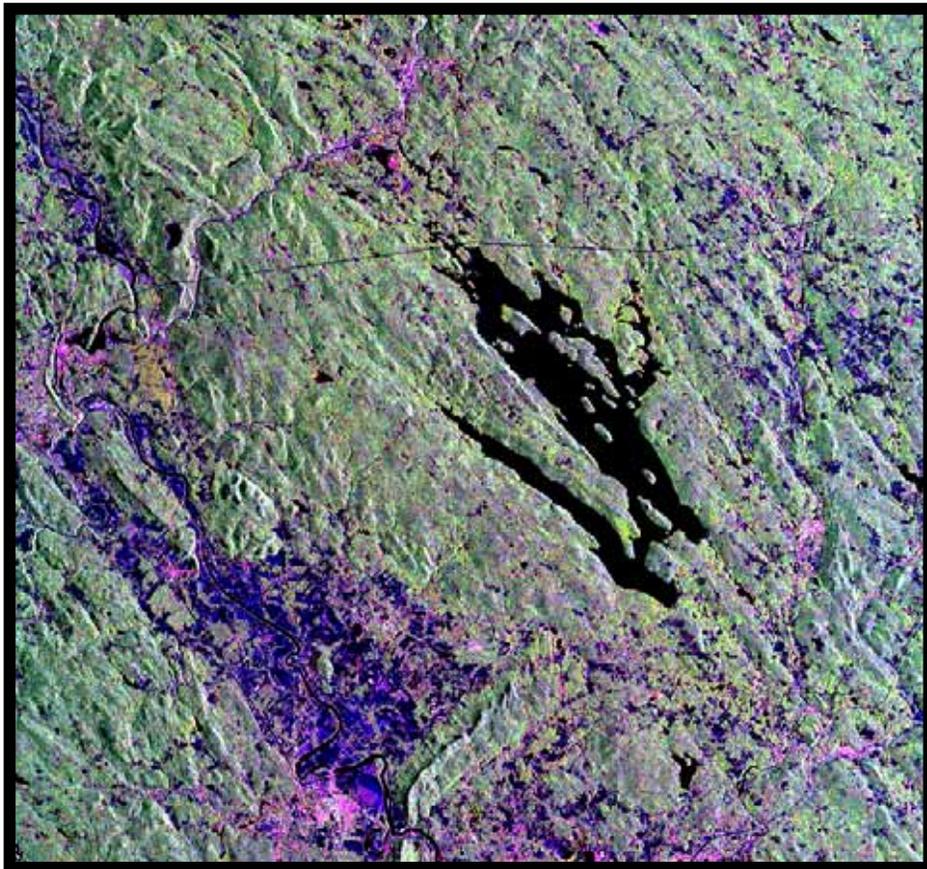




QUABBIN RESERVOIR WATERSHED SYSTEM: LAND MANAGEMENT PLAN 2007-2017



September 2007

Massachusetts Department of Conservation and Recreation
Division of Water Supply Protection
Office of Watershed Management

AUTHORS AND ACKNOWLEDGEMENTS

This 2007-2017 *Land Management Plan for the Quabbin Reservoir Watershed System* represents the combined efforts of many people both within and outside of the Department of Conservation and Recreation, Division of Water Supply Protection. Primary writing and editing responsibilities were assigned to Thom Kyker-Snowman (Environmental Analyst, Natural Resources Section), Dan Clark (Director of Natural Resources Section), Herm Eck (Chief Forester, Quabbin/Ware River Section), Jim French (Land Acquisition Coordinator, Natural Resources Section), Dennis Morin (Forester, Quabbin/Ware River Section), Randy Stone (Forester, Quabbin/Ware River Section), Marcheterre Fluet (Regional Planner, Natural Resources Section), Scott Campbell (Environmental Engineer, Quabbin/Ware River Section), Dave Small (Assistant Regional Director, Quabbin/Ware River Section), Paul Lyons (Environmental Analyst, Quabbin/Ware River Section) and Joel Zimmerman (Regional Planner, OWM). Phil Lamothe (GIS Analyst, Quabbin/Ware River Section) provided the maps and GIS plots in the plan, and Jim Taylor (Regional Planner, OWM) assisted with images. Critical review was also provided internally by Quabbin Section Environmental Quality staff (Bob Bishop, Lisa Gustavsen, and Paul Reyes), Foresters Steve Ward, Helen Johnson, and Derek Beard and Regional Director Bill Pula.

The 2007-2017 *Land Management Plan for the Quabbin Reservoir Watershed System* was approved September 17, 2007 by Richard K. Sullivan, Commissioner, Department of Conservation and Recreation, and Jonathan L. Yeo, Director, DCR Division of Water Supply Protection.

Abbreviations in text:

BOF	Bureau of Forestry, a bureau in the DCR	IPCC	International Panel for Climate Change
CMR	Code of Massachusetts Regulations	MA ESA	Massachusetts Endangered Species Act
CVA	Chicopee Valley Aqueduct		
DCR	Department of Conservation and Recreation	MEPA	Massachusetts Environmental Policy Act
DEP	Department of Environmental Protection (state)	MGL	Massachusetts General Laws
DFG	Department of Fish and Game	MWRA	Massachusetts Water Resources Authority
DFW	Division of Fisheries and Wildlife, a division of DFG	NHESP	Natural Heritage and Endangered Species Program, a DFG program
DSPR	Division of State Parks and Recreation, a division of DCR	NPDES	National Pollution Discharge Elimination System
DWSP	Division of Water Supply Protection, a division of DCR	ORW	Outstanding Resource Waters
ELU	Ecological Land Unit	OWM	Office of Watershed Management, an office of the DCR-DWSP
EOEEA	Executive Office of Energy and Environmental Affairs	PILOT	Payments in lieu of taxes
EPA	Environmental Protection Agency (federal)	QSTAC	Quabbin Scientific and Technical Advisory Committee
ESA	Endangered Species Act (federal)	QWAC	Quabbin Watershed Advisory Committee
FCPA	Forest Cutting Practices Act	SCS	Scientific Certification Systems
FSC	Forest Stewardship Council	SDWA	Safe Drinking Water Act
GIS	Geographical Information System (computer-based mapping and spatial database)	SWTR	Surface Water Treatment Rule
		WPA	Wetlands Protection Act
		WsPA	Watershed Protection Act
IESWTR	Interim Enhanced Surface Water Treatment Rule		

TABLE OF CONTENTS

1	MISSION, MANDATES, AND PLANNING PROCESS.....	1
1.1	INTRODUCTION	1
1.2	ORGANIZATIONAL STRUCTURE.....	1
1.2.1	<i>History</i>	1
1.2.2	<i>The Department of Conservation and Recreation</i>	2
1.2.3	<i>Memorandum of Understanding with MWRA</i>	2
1.2.4	<i>Water Supply Protection Trust</i>	3
1.3	MISSION.....	3
1.4	REGULATORY FRAMEWORK.....	4
1.4.1	<i>DWSP Related Acts and Regulations</i>	4
1.4.2	<i>Other Regulatory Requirements</i>	6
1.4.3	<i>Filtration Waiver</i>	9
1.5	POLICY FRAMEWORK.....	10
1.5.1	<i>Land Management Planning and the MA Climate Protection Plan</i>	10
1.5.2	<i>Third-party “Green” Certification of State Forest Lands Management</i>	11
1.5.3	<i>Ecoregional Planning</i>	11
1.5.4	<i>Forest Reserves, Large and Small</i>	13
1.6	DCR/DWSP/OWM PLANNING PROCESS.....	15
1.7	LAND MANAGEMENT PLANNING AND PUBLIC REVIEW AND INPUT PROCESS	17
1.7.1	<i>Planning and Advisory Committee Mandate</i>	17
1.7.2	<i>Public Input to DCR/DWSP’s Land Management Plans</i>	17
1.7.3	<i>Monitoring and Regular Revisions to the Quabbin Land Management Plan</i>	17
1.7.4	<i>Scientific and Technical Review (QSTAC)</i>	18
2	DESCRIPTION OF QUABBIN RESERVOIR WATERSHED RESOURCES	21
2.1	DCR/MWRA WATER SUPPLY SYSTEM.....	21
2.1.1	<i>System Description</i>	21
2.1.2	<i>Safe Yield Estimation Model</i>	23
2.1.3	<i>Quabbin Reservoir</i>	24
2.1.3.1	<i>Morphology and Bathymetry</i>	24
2.1.3.2	<i>Inflows and Outflows</i>	26
2.1.3.3	<i>Hydrodynamics</i>	26
2.1.4	<i>Overview of Quabbin Water Works</i>	28
2.1.4.1	<i>Winsor Dam and Goodnough Dike</i>	28
2.1.4.2	<i>Outlets and Aqueducts</i>	28
2.1.4.3	<i>MWRA Water Treatment Facility for the Chicopee Valley Aqueduct</i>	29
2.2	QUABBIN RESERVOIR WATERSHED OWNERSHIP AND LAND USE	29
2.2.1	<i>Current Land Uses</i>	29
2.2.2	<i>Ownership</i>	30
2.2.2.1	<i>Public Lands</i>	30
2.2.2.2	<i>Private Lands</i>	31
2.3	PHYSICAL CHARACTERISTICS OF QUABBIN WATERSHED LANDS UNDER DWSP CONTROL	31
2.3.1	<i>Watershed Delineation</i>	31
2.3.1.1	<i>Basin</i>	32
2.3.1.2	<i>Watershed</i>	32
2.3.1.3	<i>Subwatersheds</i>	34
2.3.1.4	<i>Catchments</i>	35
2.3.2	<i>Topography</i>	35
2.3.3	<i>Geology</i>	36
2.3.3.1	<i>Regional Bedrock Geology</i>	36
2.3.3.2	<i>Surficial Geology</i>	37
2.3.4	<i>Soils</i>	38
2.3.5	<i>Hydrology and Climate</i>	40
2.3.5.1	<i>Precipitation and Evaporation</i>	40
2.3.5.2	<i>Snow surveys</i>	40
2.3.5.3	<i>Streamflow</i>	42
2.3.6	<i>Developed DWSP Lands at Quabbin</i>	42
2.3.6.1	<i>Administrative Areas</i>	42

2.3.6.2	Boat Launch Sites.....	43
2.3.6.3	Powerline Rights of Way.....	43
2.3.6.4	Quabbin Park Cemetery.....	43
2.3.6.5	Fields and Other Non-Forest Areas.....	43
2.4	QUABBIN FOREST CONDITIONS.....	44
2.4.1	<i>Forest History</i>	44
2.4.1.1	Paleoenvironments.....	44
2.4.1.2	Land Use and Disturbance History.....	45
2.4.2	<i>Current Forest Conditions</i>	54
2.4.2.1	Quabbin Forest Types and Acreages.....	54
2.4.2.2	Exceptional Forests.....	56
2.4.2.3	Results from Quabbin Continuous Forest Inventory.....	57
2.4.2.4	Regeneration Conditions.....	64
2.5	QUABBIN WILDLIFE.....	64
2.5.1	<i>Current Conditions</i>	64
2.5.2	<i>Results from Periodic Wildlife Surveys</i>	65
2.5.2.1	Quabbin Park Deer Population Survey.....	65
2.5.2.2	Annual Prescott Beaver Survey Results.....	67
2.5.2.3	Roadside Breeding Bird Surveys.....	68
2.5.2.4	Moose Survey.....	69
2.6	QUABBIN BIOLOGICAL DIVERSITY.....	69
2.6.1	<i>Historic Trends</i>	69
2.6.2	<i>Biodiversity: Current Conditions</i>	70
2.6.2.1	General conditions.....	70
2.6.2.2	Quabbin Flora, Common and Uncommon.....	71
2.6.2.3	Rare, Uncommon, and Exemplary Natural Communities.....	74
2.6.2.4	Rare Wildlife Species and Habitats.....	76
2.7	QUABBIN CULTURAL RESOURCES.....	79
2.7.1	<i>Records and Documents</i>	79
2.7.2	<i>Buildings and Structures</i>	79
2.7.3	<i>Landscapes and Landscape Features</i>	80
2.7.3.1	Historical vernacular landscapes.....	80
2.7.3.2	Landscape Features.....	81
2.7.4	<i>Archaeological Resources: Prehistoric</i>	81
2.7.4.1	Prehistoric Overview.....	81
2.7.4.2	Prehistoric Archaeological Interpretation.....	82
2.7.5	<i>Archaeological Resources: Historic</i>	83
2.7.5.1	Stone Walls.....	83
2.7.5.2	Wells and Cellar Holes.....	84
3	PRINCIPLES GUIDING WATERSHED MANAGEMENT.....	85
3.1	GENERAL WATERSHED MANAGEMENT PRINCIPLES.....	85
3.1.1	<i>Watershed Protection</i>	85
3.1.2	<i>Water Yield</i>	85
3.1.3	<i>Water Quality</i>	86
3.1.4	<i>Unfiltered Water Supply Regulatory Requirements</i>	86
3.2	BASIC PRINCIPLES OF FOREST HYDROLOGY.....	88
3.2.1	<i>Forests and Water Yield</i>	88
3.2.2	<i>Forests and Water Quality</i>	88
3.3	THE VALUE OF FORESTS IN PROTECTING DRINKING WATER SUPPLIES.....	89
3.4	THE EFFECTS OF DISTURBANCE ON THE WATERSHED PROTECTION FOREST.....	92
3.4.1	<i>General Types, Frequency, and Principles of Disturbance</i>	92
3.4.2	<i>Specific Disturbances</i>	93
3.4.2.1	Weather Events.....	93
3.4.2.2	Fire.....	95
3.4.2.3	Insects and Diseases.....	96
3.4.2.4	Climate Change.....	97
3.4.2.5	Air Pollution and Forested Water Supplies.....	98
3.5	RESISTANCE AND RESILIENCE IN THE WATERSHED FOREST AND THE ROLE OF MANAGEMENT.....	105
3.5.1	<i>Forest Filtration: Redundancy and Diversity</i>	105
3.5.2	<i>Nutrient Dynamics</i>	106
3.5.3	<i>Forest Structure and Water Yield</i>	107

3.5.4	<i>The Importance of Pattern</i>	108
3.5.5	<i>Age Structure and Resiliency</i>	109
3.5.6	<i>The Effects of Management on Resistance and Resilience: A Working Hypothesis</i>	110
3.5.7	<i>Wildlife Effects</i>	112
4	WATERSHED MANAGEMENT GOALS	113
4.1	DRINKING WATER PROTECTION GOALS	113
4.1.1	<i>Water Quality Goals</i>	113
4.1.2	<i>Water Yield Goal</i>	114
4.2	LAND PROTECTION GOALS	114
4.3	LAND MANAGEMENT GOALS	115
4.3.1	<i>Goals for DWSP-Controlled Forested Areas under Active Management</i>	115
4.3.2	<i>Goals for Non-Management Areas with Forest Cover</i>	117
4.3.3	<i>Management Goals for Non-Forested Areas</i>	117
4.4	WILDLIFE MANAGEMENT GOALS	118
4.5	BIOLOGICAL DIVERSITY PROTECTION GOALS.....	119
4.6	CULTURAL RESOURCES PROTECTION GOALS	120
5	MANAGEMENT PLAN OBJECTIVES AND METHODS: 2007-2017	121
5.1	LAND PROTECTION	121
5.1.1	<i>Land Acquisition</i>	121
5.1.1.1	1985-2006 Land Acquisition Program.....	121
5.1.1.2	Future Land Acquisition Objectives	122
5.1.1.3	Payments In-Lieu of Taxes (PILOT) Program	122
5.1.1.4	Land Disposition Policy	124
5.1.2	<i>Protection of Private and Community-Owned Lands</i>	126
5.1.2.1	Conservation Restrictions.....	126
5.1.2.2	Technical Assistance to Communities.....	127
5.1.2.3	Technical Assistance to Private Forest Landowners.....	128
5.1.3	<i>Boundaries</i>	129
5.1.3.1	Maintenance of Boundaries	129
5.1.3.2	Encroachment Discovery and Response.....	129
5.1.3.3	Cooperation with Abutters.....	129
5.1.3.4	Rights-of-Way	130
5.1.4	<i>Public Education</i>	131
5.1.4.1	Role of DWSP Watershed Rangers in Land Protection.....	131
5.1.4.2	Interpreting Land Protection/Management Priorities.....	133
5.1.5	<i>Fire Protection</i>	133
5.1.6	<i>Security and Emergency Planning</i>	134
5.2	MANAGEMENT OF FORESTED LANDS	136
5.2.1	<i>History of Quabbin Watershed Forestry 1930 – 1960</i>	136
5.2.1.1	Land Taking and Development for Water Supply	136
5.2.1.2	Establishment and Management of Plantations on Open Lands	137
5.2.2	<i>Objectives and Accomplishments of Previous Quabbin Management Plans</i>	138
5.2.2.1	Hunt’s 1961 Assessment	138
5.2.2.2	Spencer/Walker 1972 Quabbin Watershed Management Plan	139
5.2.2.3	Spencer/Lyons 1986 Quabbin Watershed Forest and Wildlife Management Plan	140
5.2.2.4	MDC Quabbin Land Management Plan 1995-2004	141
5.2.2.5	Regeneration Changes during the Previous Management Period	142
5.2.3	<i>DCR/DWSP Quabbin Forest Management Objectives 2007-2017</i>	144
5.2.3.1	Primary Objectives	144
5.2.3.2	Subwatershed Administration of Forest Management.....	145
5.2.3.3	Establishment of Forest Management Zones.....	148
5.2.3.4	Harvesting Limits Within and Among Zones	151
5.2.3.5	Protection Provided for Water and Wetland Resources by Zones	153
5.2.3.6	Species Composition Objectives	154
5.2.4	<i>Implementation of the Forest Management Approach</i>	158
5.2.4.1	Silvicultural Practices.....	159
5.2.4.2	Silviculture by Forest Type	162
5.2.4.3	Summary of Planned Silvicultural Activities.....	165
5.2.4.4	Comparison of Forestry in the 1995-2004 versus the 2007-2017 Quabbin Land Management Plans	166
5.2.5	<i>Current Threats: Forest Insects, Diseases, and Invasive Exotic Plants</i>	168

5.2.5.1	Hemlock Woolly Adelgid and DWSP Policy for Managing Impacts	168
5.2.5.2	Other Insect or Disease Threats	173
5.2.5.3	Invasive Plants	174
5.2.5.4	Salvage Policy	174
5.2.6	<i>Conservation Management Practices (CMPs) for Watershed Forest Management</i>	174
5.2.6.1	Variables	175
5.2.6.2	Logging Equipment	175
5.2.6.3	Silvicultural Planning	179
5.2.6.4	Operator Workmanship	179
5.2.6.5	Filter Strips	179
5.2.6.6	Buffer Strips	179
5.2.6.7	Wetlands	180
5.2.6.8	Logging Practices	182
5.2.6.9	Point-Source Pollution Control	185
5.2.6.10	Fire Prevention	186
5.2.6.11	Protection of Residual Vegetation	186
5.2.6.12	Cultural Resource Protection	186
5.2.6.13	Aesthetics	186
5.2.7	<i>Control of Harvest Operations through Timber Sale Permit</i>	187
5.2.7.1	Introduction	187
5.2.7.2	Water Quality Specifications	187
5.2.7.3	Harvesting Specifications	187
5.2.7.4	Harvesting Systems	187
5.2.8	<i>Internal Review of Proposed Harvesting</i>	188
5.2.9	<i>Post-harvesting Monitoring and Reporting</i>	190
5.2.10	<i>Annual Reporting of Implementation Results</i>	190
5.3	MANAGEMENT OF OTHER DWSP LANDS	191
5.3.1	<i>Grounds around Administration Areas</i>	191
5.3.2	<i>Boat Launch Areas 1, 2 & 3</i>	191
5.3.3	<i>Maintained Open Land</i>	192
5.3.4	<i>Viewsheds</i>	192
5.3.5	<i>Quabbin Park Recreation Areas</i>	193
5.3.6	<i>Access Roads</i>	193
5.3.6.1	Road Categories	194
5.3.6.2	Criteria for Determining Hydrologic Road Sensitivity	196
5.3.6.3	Regular Review of Access Road Maintenance Needs	196
5.3.6.4	Pre-Planned Spill Response for Silvicultural Operations	197
5.3.6.5	Conservation Management Practices for Road Maintenance	198
5.3.6.6	Internal Review of Proposed Roadwork or Gravel Operations	199
5.3.6.7	Beaver Populations in Long-term Planning for Access	200
5.3.6.8	Management Guidelines for Beaver at Road Stream Crossings	200
5.4	WILDLIFE MANAGEMENT	201
5.4.1	<i>Assessment of Impacts of Planned Watershed Management Activities</i>	201
5.4.2	<i>Active Management to Enhance Habitat for Selected Wildlife Species</i>	201
5.4.2.1	Bald Eagles	201
5.4.2.2	Common Loons	202
5.4.2.3	Nest Boxes for Land Birds	203
5.4.2.4	Snake Hibernacula	203
5.4.3	<i>Conservation Management Practices (CMPs) for Wildlife Management</i>	204
5.4.3.1	Habitat Features and Management Recommendations	204
5.4.3.2	Considerations during Timber Marking, Harvesting, and Other Land Management Activities	215
5.4.4	<i>Population or Impact Monitoring and Control Plans</i>	219
5.4.4.1	Beaver	219
5.4.4.2	Birds	225
5.4.4.3	Burrowing Animals	228
5.4.4.4	White-Tailed Deer	228
5.4.4.5	Moose	230
5.5	MANAGEMENT AND PROTECTION OF BIOLOGICAL DIVERSITY	232
5.5.1	<i>Biodiversity Mandate: Programmatic and Regulatory Framework</i>	232
5.5.2	<i>Massachusetts Biodiversity Objectives and Accomplishments: 1995-2007</i>	234
5.5.2.1	Statewide Biodiversity Initiatives	234
5.5.2.2	Quabbin Biodiversity Initiatives	235
5.5.3	<i>Areas with Special Management Restrictions and Small Reserves</i>	236

5.5.4	<i>Management for Special Conditions</i>	239
5.5.4.1	Primary Forests.....	239
5.5.4.2	Late Seral Forest Conditions	240
5.5.4.3	Early Successional Forest Habitat	240
5.5.4.4	Early Successional Non-Forest Habitat Management Practices	243
5.5.5	<i>Invasive Plants Management</i>	244
5.5.5.1	Definitions.....	244
5.5.5.2	Problems Associated with Invasive Plants.....	245
5.5.5.3	Control and Management Options.....	246
5.6	PROTECTION OF CULTURAL RESOURCES.....	250
5.6.1	<i>Silviculture and Cultural Resource Management: Prehistoric Sites</i>	250
5.6.2	<i>Silviculture and Cultural Resource Management: Historic Sites</i>	251
6	RESEARCH, INVENTORY, AND MONITORING NEEDS	253
6.1	FOREST AND FORESTRY NEEDS.....	253
6.2	WILDLIFE AND WILDLIFE MANAGEMENT NEEDS.....	254
6.3	BIOLOGICAL DIVERSITY MAINTENANCE NEEDS	255
6.4	LONG RANGE CULTURAL RESOURCE INVENTORY AND MANAGEMENT INITIATIVES	255
7	PUBLIC INVOLVEMENT: PUBLIC REVIEW AND COMMENTS	257
8	LITERATURE CITED AND GENERAL REFERENCES	261
9	GLOSSARY OF TERMS	285
10	APPENDICES	291
10.1	APPENDIX I: 2004 MWRA / DCR MOU	291
10.2	APPENDIX II: LEGISLATION.....	291
10.2.1	<i>Acts of 1972 Chapter 737 (the Kelley-Wetmore Act)</i>	291
10.2.2	<i>350 CMR 11.00 Watershed Protection Regulations</i>	294
10.2.3	<i>Watershed Management Plan Legislation</i>	320
10.2.4	<i>Advisory Committee Legislation</i>	321
10.2.5	<i>Deer Management Regulations</i>	321
10.3	APPENDIX III: QUABBIN FLORA	323
10.4	APPENDIX IV: 2004 QUABBIN REGENERATION SUMMARY REPORT.....	327
10.5	APPENDIX V: TECHNICAL ASSISTANCE TO COMMUNITIES: PROJECTS 1994-2006	336
11	INDEX	339

LIST OF TABLES

TABLE 1: LEGISLATIVE ACTS RELEVANT TO THE DWSP OFFICE OF WATERSHED MANAGEMENT	5
TABLE 2: FEDERAL AND STATE LAWS AND REGULATIONS AFFECTING OWM RESOURCE PROTECTION ACTIVITIES	7
TABLE 3: LARGE (MATRIX) FOREST RESERVE SITES ON STATE LAND	14
TABLE 4: DCR/DWSP/OFFICE OF WATERSHED MANAGEMENT PLANNING SUMMARY	16
TABLE 5: DWSP WATERSHED AREAS AND WITHDRAWALS FROM SYSTEM SOURCES, 1990-2000	21
TABLE 6: MORPHOLOGY OF QUABBIN AND WACHUSETT RESERVOIRS	24
TABLE 7: INFLOWS TO QUABBIN RESERVOIR	27
TABLE 8: OUTFLOWS FROM QUABBIN RESERVOIR	27
TABLE 9: LAND COVER, LAND USE, AND POPULATION DENSITY BY WATERSHED	29
TABLE 10: DCR/DWSP LAND HOLDINGS AND OTHER PROTECTED WATERSHED LANDS	30
TABLE 11: PUBLIC AGENCY LAND HOLDINGS WITHIN THE QUABBIN RESERVOIR WATERSHED	30
TABLE 12: LAND OWNERSHIP WITHIN THE QUABBIN RESERVOIR WATERSHED	31
TABLE 13: ACRES OF QUABBIN RESERVOIR WATERSHED BY SLOPE CLASS	36
TABLE 14: ACRES OF COMPOSITE SOIL TYPE BY BLOCK ¹	39
TABLE 15: TOTAL ANNUAL PRECIPITATION MEASURED AT BELCHERTOWN STATION	41
TABLE 16: STREAMFLOW DATA FOR SELECTED TRIBUTARIES OF THE QUABBIN RESERVOIR	42
TABLE 17: QUABBIN RESERVOIR WATERSHED PUBLIC ACCESS RULES SUMMARY	52
TABLE 18: QUABBIN FOREST TYPES AND ACREAGES	54
TABLE 19: TOTAL CFI BASAL AREA (SQ FT) BY SPECIES AND CHANGES FROM 1990 TO 2000	59
TABLE 20: CFI PLOT DISTRIBUTION COMPARED TO ACREAGES BY FOREST TYPE	60
TABLE 21: TREE SPECIES DISTRIBUTION IN 2000 CFI	61
TABLE 22: DIAMETER DISTRIBUTION ON CFI IN 2000	62
TABLE 23: SAWLOG VOLUMES BY SPECIES BASED ON 2000 CFI	63
TABLE 24: ANNUAL BOARD FOOT VOLUME GROWTH ESTIMATED FROM 1990 AND 2000 CFI MEASUREMENTS	63
TABLE 25: TREE REGENERATION 1989 VS. 2004	64
TABLE 26: DETAILS OF QUABBIN PARK LINE-TRANSECT SURVEYS, 2001-2003	66
TABLE 27: DETAILS OF SURVEY EFFORT FOR LINE-TRANSECT SURVEY IN QUABBIN PARK, 2001-2003	66
TABLE 28: STATE LISTED PLANTS OCCURRING ON DWSP QUABBIN PROPERTIES	71
TABLE 29: UNCOMMON PLANTS POTENTIALLY OCCURRING ON DWSP PROPERTIES	71
TABLE 30: HABITATS IN WHICH RARE SPECIES ARE LIKELY TO BE FOUND IN THE QUABBIN RESERVOIR WATERSHED	72
TABLE 31: STATUS OF RARE COMMUNITIES ON THE QUABBIN RESERVOIR WATERSHED	76
TABLE 32: STATUS OF STATE-LISTED VERTEBRATE SPECIES WHOSE RANGES OVERLAP DWSP QUABBIN PROPERTIES	78
TABLE 33: POPULATION OF SWIFT RIVER VALLEY, 1830-1938	83
TABLE 34: OPEN SPACE PROTECTION IN QUABBIN BASINS WITH ACQUISITION OPPORTUNITIES	122
TABLE 35: PAYMENT-IN-LIEU OF TAXES FY05-FY06, QUABBIN RESERVOIR WATERSHED COMMUNITIES	124
TABLE 36: PRIVATE LANDS FORESTRY ASSISTANCE	128
TABLE 37: QUABBIN WATERSHED RANGER INTERVENTIONS, 1999-2005	132
TABLE 38: ACRES OF SILVICULTURAL TREATMENT BY FISCAL YEAR, 1960-1995	141
TABLE 39: HARVESTING SUMMARY FOR FY1995 THROUGH FY2005	142
TABLE 40: REGENERATION COMPARISON 1989, 1994, 2004	143
TABLE 41: ACRES BY MANAGEMENT ZONE	153
TABLE 42: TOP TEN QUABBIN OVERSTORY SPECIES IN 2000	154
TABLE 43: HARVESTING AT QUABBIN FISCAL YEARS 1996-2005	167
TABLE 44: EXAMPLE OF A POSSIBLE CUTTING PATTERN DURING FY 2007-2017, BY FOREST MANAGEMENT ZONES	167
TABLE 45: HARVESTING METHODS/EQUIPMENT USED ON DWSP WATERSHED LANDS	176
TABLE 46: SAMPLE SKIDDER SIZES AND GROUND PRESSURES	177
TABLE 47: SAMPLE FORWARDER SIZES AND GROUND PRESSURES	177
TABLE 48: HARVESTING METHODS/EQUIPMENT USED IN VARIOUS SOIL/TERRAIN COMBINATIONS	178
TABLE 49: PROTECTION MEASURES APPLIED TO VARIOUS STREAM CROSSING SITUATIONS	185
TABLE 50: BOAT LAUNCH AREAS - RECORDED VISITORS DURING 2006 SEASON	192
TABLE 51: MAINTAINED OPEN LANDS AT QUABBIN	192
TABLE 52: ROAD CATEGORIES IN THE QUABBIN RESERVOIR WATERSHED	194
TABLE 53: OPTIMUM NUMBER OF SNAGS/DEN TREES PER 100 ACRES BY HABITAT TYPE	209
TABLE 54: NUMBER OF CAVITY TREES NEEDED TO SUSTAIN NEW ENGLAND WOODPECKER POPULATIONS	211
TABLE 55: KNOWN AND POTENTIAL BREEDING RAPTORS AT QUABBIN	215
TABLE 56: NUMBER OF CANADA GOOSE NESTS AND EGGS TREATED 1999 -2007, TO PREVENT HATCHING	227
TABLE 57: DEER HARVEST AND HUNTER SUCCESS RATE, 1991 TO 2005	229

TABLE 58: AREAS WITH SPECIAL MANAGEMENT RESTRICTIONS WITHIN THE QUABBIN RESERVOIR WATERSHED.....	237
TABLE 59: INVASIVE PLANTS PRESENT ON THE QUABBIN RESERVOIR WATERSHED.....	246
TABLE 60: MAJOR INVASIVE PLANTS ON QUABBIN WATERSHED AND CONVENTIONAL CONTROL MEASURES	247

LIST OF FIGURES

FIGURE 1: MWRA WATER SUPPLY SYSTEM SCHEMATIC	22
FIGURE 2: MWRA WATER DEMAND VS. SYSTEM SAFE YIELD.....	23
FIGURE 3: QUABBIN RESERVOIR BATHYMETRY.....	25
FIGURE 4: CHICOPEE RIVER DRAINAGE BASIN AND QUABBIN RESERVOIR.....	32
FIGURE 5: QUABBIN RESERVOIR WATERSHED MAJOR HYDROGRAPHY	33
FIGURE 6: SUBWATERSHEDS OF QUABBIN RESERVOIR WATERSHED	34
FIGURE 7: QUABBIN RESERVOIR WATERSHED HIERARCHY	35
FIGURE 8: QUABBIN RESERVOIR WATERSHED PUBLIC ACCESS MAP.....	51
FIGURE 9: MAP OF QUABBIN PARK	65
FIGURE 10: BEAVER SURVEY RESULTS FROM PRESCOTT PENINSULA, 1952-2006	68
FIGURE 11: TOTAL NUMBER OF BIRDS AND BIRD SPECIES RECORDED DURING ANNUAL ROADSIDE SURVEYS, 1995-2005..	69
FIGURE 12: AMPLITUDE OF WIND DISTURBANCE IN UNMANAGED VS. MANAGED FORESTS.....	107
FIGURE 13: SAMPLE “T-SHEET” FOR POWERLINE ROW.....	130
FIGURE 14: SUBWATERSHEDS AND DIRECT DRAINAGE AREAS WITHIN THE QUABBIN RESERVOIR WATERSHED	146
FIGURE 15: EXAMPLE OF A SUBWATERSHED PLANNING MAP INCLUDING TOPOGRAPHY, SOILS, AND PREVIOUS HARVESTS	148
FIGURE 16: QUABBIN FOREST MANAGEMENT ZONES	150
FIGURE 17: HYPOTHETICAL EXAMPLE OF SILVICULTURAL PLANNING.....	180
FIGURE 18: TIMBER HARVESTING GUIDELINES NEAR VERNAL POOLS	181
FIGURE 19: MID-WINTER BALD EAGLE COUNTS AT QUABBIN RESERVOIR AND STATEWIDE, 1986-2005	202
FIGURE 20: DECOMPOSITION OF SNAGS AND COARSE WOODY DEBRIS	210
FIGURE 21: FOREST OPENING PLANNED WITH WILDLIFE CONSIDERATIONS	217
FIGURE 22: PATHOGEN CONTROL ZONES AT QUABBIN	220
FIGURE 23: POTTAPaug NATURAL AREA	239
FIGURE 24: POTENTIAL NUMBER OF WILDLIFE SPECIES BY SILVICULTURAL SYSTEM AND COVER-TYPE GROUPS	242

This page left intentionally blank.